Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Amendment to the Commission's Rules	)	Docket No. 12-354
With Regard to Commercial Operations	)	
In the 3550-3650 MHz Band	)	

COMMENTS OF
SPECTRUM BRIDGE, INC.

Executive Summary

Spectrum Bridge, Inc. ("Spectrum Bridge") strongly supports the FCC goal to create a new Citizens Broadband Service in the 3550-3650 MHz band (3.5 GHz Band) currently utilized for military and satellite operations. Making 150 megahertz of contiguous spectrum available for innovative mobile, and fixed wireless, broadband services is a significant step in ensuring compelling wireless broadband services thrive. Furthermore, promoting innovation in this band will result in significantly more wireless capacity and ensure competitive and compelling wireless service offerings remain available to the American Public. The proposed NPRM is complex, and asks a number of questions. In these comments Spectrum Bridge addresses many of the relevant issues. We do so from experience acquired over many years of providing a secondary market place for spectrum, providing spectrum sharing databases (5GHz and VHF/UHF TV White Space), and providing Spectrum Management and Spectrum planning services to the wireless industry.

Specifically we support the prioritized database access approach with the notion

that the database can accommodate a much more flexible approach to priority and spectrum allocation than suggested by the NPRM. The already proven database approach also allows for much more flexible operating rules for the devices that will share the band. We encourage the FCC to recognize that the database approach allows for the FCC to rapidly deploy solutions in a conservative manner while providing the capability to dynamically manage and control access as the use of the band changes over time, and that the database approach allows for the incorporation of other sharing technologies as they mature.

Finally Spectrum Bridge believes that the radio and database technologies are sufficiently mature and available to support immediate deployment of trials and experiments to validate the assumptions and investigate the issues raised in the NPRM.

/s/ Peter Stanforth February 20, 2013

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The technology needed to realize multi-tiered spectrum sharing between is available today

Spectrum Bridge has developed comprehensive Spectrum Management technology, sometimes referred to as a Spectrum Access System (SAS), capable of allocating spectrum and protecting incumbent users on a real-time basis. Spectrum Bridge's TVWS geo-location database solution was built on this extensible spectrum management platform and is compatible with the proposed n-tiered (and other) frameworks contemplated in the NPRM.

This technology, recently demonstrated to the FCC[1] and DOD is clearly capable of supporting the three-tiered licensing proposal described in the PCAST report on spectrum sharing, as well as the FCC's NPRM on spectrum sharing and would afford virtually any type of incumbent spectrum user the ability to operate on a fully protected basis. Furthermore, the use of small cell technology could be directly supported within any tier and ensure more efficient spectrum use in underutilized portions of the 3.5 GHz band. It also provides the capability to enable payment for QOS assurances.

The three tier multi-tiered framework, proposed as the Citizens Broadband Service, which would operate within a multi-tiered shared access model that reflects the PCAST recommendation, is exactly that - a framework. As a framework, policies can be established to facilitate configurable rules by: tier, time, geography, frequency, radio access technology, user or other parameters. By using a cloud-based spectrum management platform, such as that developed by Spectrum Bridge, rules can be

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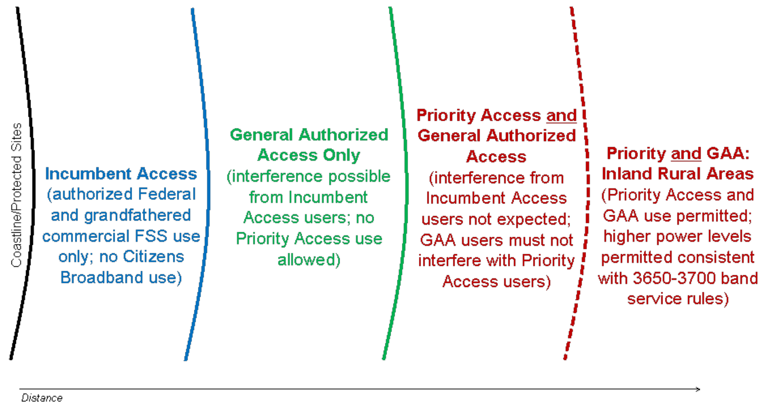
[1] http://apps.fcc.gov/ecfs/comment/view?z=to5tn&id=6017163707

dynamically configured and applied in real time, providing significant flexibility in how and when policies are applied.



This technology is configurable and extensible such that various user types within each tier can be configured with unique operating parameters appropriate for the intended use. For example, the schema denoted above and in the NPRM could be configured exactly as specified or alternative scenarios could be implemented. For example GAA users could be configured to enable more separation between Incumbent Access users, while Priority users could be enabled with greater access, allowing them to operate in closer proximity to Incumbents without interference to incumbents. .

It is unclear whether license by rule (as opposed to unlicensed or fully licensed operation) will directly result in greater <u>interference protection status</u>, especially in the GAA tier. However, rules can be created to stimulate an ecosystem capable of facilitating co-existence. Today the part 90 licensing scheme that applies to 3.65 GHz operations, does little other than create an awareness of where users might be operating. This is useful, however the way it is implemented may not be practical for promoting interference protection status, as the registration process is manual, prone to error and is not executed in real time. Regardless of the licensing model that is adopted, the use of an SAS system will enable the ability to enable co-existence, mitigate interference risks to incumbent and priority users and enable greater interference protection in all tiers. Some additional clarification on the FCC's license by rule model would be useful in making a determination on effectiveness.

- Appropriate licensing schemes –Licensing schemes can be implemented by tier. **Incumbent** users – licensed, with the ability to dynamically allocate, reserve and modify spectrum use; **Priority** users - lightly licensing scheme similar to 3.65 GHz model; **GAA** users – unlicensed with registration and spectrum management system similar to TVWS.
- Specific flexible and resilient interference mitigation technologies and techniques that could be implemented by Citizens Broadband Service users – SAS technology exists that is fully capable of enabling co-existence and mitigating interference in a shared spectrum ecosystem. Systems and methods are described in industry proceedings and systems have been demonstrated.

By virtue of various licensing models, fixed site registration (manual and fully automated), exclusive and non-exclusive access, and a cloud bases SAS, the implementation of a very effective spectrum management is enabled, through real-time coordination and data sharing.

Although solutions exist to virtually eliminate the threat of interference to incumbents and priority users, the suitability of shared spectrum bands for “mission critical” operations should be carefully considered, as should the definition of mission critical applications. This may well extend beyond the obvious to include commercial entities that support mission critical applications. Because the threat of interference is finite in any band, steps must be taken, in any situation to ensure reliable operation. Given these facts, it is conceivable that as SAS technology matures, this might eventually be the most appropriate method for enabling mission critical and interference free wireless systems. At this point it is perhaps most appropriate for candidate users and operators to decide if or which “mission critical” applications could be managed using an SAS approach with minimal risk.

We have also contemplated the applicability of the Citizens Broadband service, including GAA and Priority Access tiers, to federal users. When federal users access bands for non-critical applications (e.g. Wi-Fi) they could simply access the spectrum via GAA status. Otherwise, better preferences (priority access) would greatly diminish the value and utility of this band for general or commercial GAA users. Federal users could simply establish priority access when necessary; therefore no additional distinction or additional tiers would be necessary.

Because SAS technology is flexible and extensible, the specific operational requirements for each tier does not need to be defined in explicit terms today, nor are we constrained to a specific set of operation parameters over time. However, efforts should be made to ensure: a) Incumbent users receive adequate protection; b) Priority users can gain exclusive and unfettered access to unused portions; c) GAA users have access to significant, remaining portions of 3.55-3.65 GHz spectrum, including a critical mass that is substantial enough to promote the development and deployment of compelling commercial solutions and technologies. It is also assumed that Incumbent users would not be required to mitigate any interference to the lower service tiers. Similarly, it is assumed that Priority users would also not be required to mitigate any interference to the GAA tier.

Small cell operation at frequencies > 3 GHz can be tightly controlled and managed, virtually eliminating risk to incumbents

Priority Access operations could be accommodated and opens up the possibility for more innovative use of this and other bands. Priority access can easily be managed by an SAS system.

To simply allocate the band in two equal halves is perhaps an unnecessary and artificial limitation. A simplified approach would guarantee a certain amount (e.g. ~20 MHz) of spectrum as a critical mass, for use by various tiers. This would ease concerns regarding availability and ensure access to some amount of spectrum by all parties. Clearly an arbitrary allocation of 50 MHz of spectrum to any tier would not be in the public's best interest or efficient in terms of allocation. This was exhibited by the general underutilization the 50 MHz of spectrum allocated to the 4.9 GHz public safety band.

Any channelization plan can be accommodated and managed via a SAS. Channel plans may promote more standardized use of the band. However a strict requirement to comply with a specific channel band will stifle innovation.

Low power/small cell operation should have little impact along international borders. Interference mitigation could be achieved entirely through the implementation of a buffer zone enforced by the SAS, or other cooperative agreements as they are adopted over time. Similar challenges have been addressed and solutions implemented in TVWS.

The costs of implementing an SAS are not significant when compared to the others costs and benefits of deploying wireless technology

Spectrum Bridge provides the TVWS solution at no cost to the Government or to incumbents (Broadcasters). Spectrum Bridge generates operating revenue to support the system from services it provides to secondary users of the spectrum.

Implementation and operational costs of an SAS system are minimal when amortized across the total costs of implementing, deploying and maintaining a 3.5 GHz wireless eco-system. Furthermore, the operational costs of SAS operations would be incorporated into the cost of goods sold (radio devices) and virtually eliminated with respect to costs incurred by regulatory agencies, notwithstanding oversight. The SAS concept also allows for business opportunities for value added services and transactional revenue services to offset the operating costs.

Spectrum Bridge has built and certified a TVWS database. The spectrum management technology developed for TVWS is fully extensible and can support the concepts and framework proposed within the NPRM. Clearly, rules and policies must be further defined; however Spectrum Bridge has demonstrated a fully functional spectrum management system that supports many of the proposed and anticipated requirements contemplated within the NPRM. These features include the ability to support n-tier users, spectrum allocation policies, configurability to support various interference models, incumbent protection and pre-emption. The number of databases ultimately depends on a number of factors, but today's TVWS database solutions incorporate, access, and interoperate with numerous internal and external databases, so this is not seen as a risk in implementing a solution for the 3.55-3.65 band.

Also of critical importance is defining and specifying incumbent protection. It is expected that this data could be sensitive or classified and dynamic. Technology is clearly not a limiting factor with respect to implementation, protection and use of sensitive or dynamic data. Implementation will be most affected by access, availability and policy.

Government and Military access and use of spectrum can be adequately protected within the context of an SAS. Currently, within the TVWS ecosystem, many responsibilities are shared between multiple certified database providers, the FCC and industry organizations, demonstrating effective cooperation and the ability to manage and share critical data. Government and Military users need only provide enough information to accomplish two complementary goals: 1) to ensure adequate protection of the Incumbent user; 2) to provide enough information for the SAS to determine if the incumbent use would potentially interfere with the secondary or tertiary user.

Candidate database providers should provide compelling credentials and proposals to be considered

Multiple database providers are not a problem and contribute significantly to collaboration and ensure a healthy competitive landscape. However, candidate providers should provide compelling credentials and proposals to be considered. Due diligence should also be performed on candidate proposals. The consequence of not properly qualifying candidates places a burden on committed and well-qualified candidates and diminishes the return on investment necessary to thrive as a commercial enterprise and offer a compelling and reliable service. Furthermore, the overhead and expense of coordinating solutions between providers induces considerable expense and overhead, especially when there is only casual interest in the development of policy.

Considerations regarding database (SAS) implementation

Spectrum Bridge believes that significant effort and attention should be invested in ensuring the integrity, reliable performance and protection of incumbent users in a shared spectrum ecosystem. This is accomplished everyday in virtually every band, with minimal enforcement actions and interference issues. In fact, one can argue that with an SAS, coordination could actually be improved and interference issues further reduced. However, in any wireless system, it is very difficult to prevent malicious intent or create 100% tamper proof devices. The technology is available today to minimize the risk to operations, outside of established rules and operating parameters. This is accomplished through the use of well constructed policy, reliable geo-location services, security protocols, rigorous certification, a device registration system and checks and balances afforded through collaboration and publicly accessible data. In fact, great confidence in this model has been achieved through the TVWS ecosystem.

Additional checks and balances can be added, commensurate with the criticality of incumbent operations. For example, more comprehensive registration data and processes, variable query intervals, and event driven query intervals are all reasonable operating parameters and all can be supported with existing technology.

The TVWS model serves as an effective model and viable approach. As such, this working model can and should be used as a reference to define additional capabilities that should be implemented and extend the spectrum sharing model.

GPS is perhaps the most technically superior and cost effective solution available for geo-location determination. However, location technology should not be limited strictly to GPS, as there are very effective alternatives that can provide location capability in situations where GPS is ineffective or inoperable. Although, other technologies may be less accurate or reliable, this can be factored into the allocation process using a continuum of operational parameters such as: TX power, emissions, antenna height, and separation distances (protection criteria).

A wide variety of industry standard secure protocols, authentication and transport mechanisms are available and widely adopted. Many of which can be cost effectively implemented. The use of industry standards should be maintained.

Sharing of portions or all public data is technically feasible. Spectrum Bridge maintains strict confidentiality of customer data and ensures the protection of data where necessary. However, we currently have no opinion on whether or what specific data should be available to the public.

By nature SAS, database and cloud computing technology is configurable, extensible and can evolve quickly with changing requirements and demands. Sufficient technical requirements should be specified to ensure effective protection of incumbents and innovative uses of shared spectrum. However, over specifying the implementation strategy or limiting other value added services or enhancements that can be made to promote more efficient spectrum sharing should be avoided, as flexibility is the fuel for innovation.

RF Protection of Radar Services and Small Cells in 3.5 GHz

The deployed small cell systems are able to tolerate interference from the Radar and so mandating protection against damage from Radar is not required. An example of this is the resilience of devices manufactured for unlicensed ISM band operation, where little care is taken by users to avoid situations where devices are regularly subjected to relatively high power RF stimulus. This is often seen in the TVWS ecosystem where small cell devices are exposed at close range to > 1MW transmitters. Equipment manufacturers can solve this problem leveraging information available from the database in the deployment methodologies. The database should be the primary enabler for protecting small cell systems from Radar interference providing this information to the deployed systems.

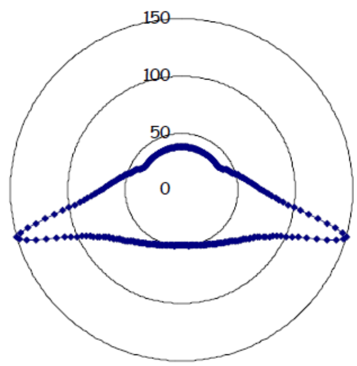
It is not clear that secondary devices will create accumulated additive noise that will impact the operation of Radar. However the database can mitigate any real world occurrences of interference by adjustment of the spectrum assignment parameters, by time, location, frequency and power to control the secondary devices.

RF Protection of Incumbent FSS Sites is essential but should be realistic and flexible

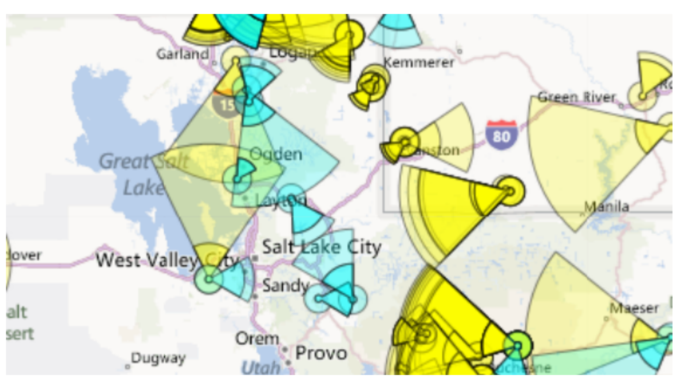
As previously contemplated in the FCC's *Report and Order and Memorandum Opinion and Order: Wireless Operations in the 3650-3700 MHz Band, Appendix D, A Methodology For Locating Fixed Stations Within The FSS Earth Station Protection Zone*[2], a framework was proposed to determine a safe distance within the FSS earth station protection zone where a fixed station can be located without increasing the potential of that station to cause harmful interference to the earth station. This practical approach, considered the fact that FSS earth stations are generally not operating in the worst case configuration. More specifically, the elevation angle of an earth station varies in relationship to the position of the geostationary satellite with which it communicates. Further, the range of pointing azimuths and elevation angles that an earth station uses varies with its location - as earth stations are

[2] FCC 05-56, Adopted, March 16, 2005

located at higher latitudes, the size of the visible geostationary arc decreases. This limits the available azimuth angles and the elevation angles necessary to see these satellites. An example provided by the FCC is depicted as follows:



Variable separation distances, as a function of latitude, longitude and azimuth can be readily calculated and enforced by the SAS. A similar system is already implemented today.   Irregular shape files are regularly computed and applied to create [dynamic] zones of protection for incumbent users in the TVWS ecosystem. The following illustrated several complex shapes that are computed to enable incumbent protection:



Operational parameters should not limit or define radio access technology

In order to promote the most innovative and useful applications in the 3.5 GHz band, the creation and adoption of existing or new technologies should not be limited by rule or policy. Although TVWS rules are technology agnostic, the unfortunate consequence of extremely stringent out of band emissions requirements (-55 dB) has thwarted the adoption of available, widely adopted and extremely useful technologies such as these employed in other unlicensed bands (e.g. 802.11 OFDM based technologies).

The equipment authorization process defined for unlicensed TVWS device operation including emissions and SAS interoperability has proven adequate and effective. However, the process must be administered in a more efficient manner. Currently, the FCC still reviews test reports provided through the TCB process. This is perhaps warranted, however significantly more diligence and attention should be invested in ensuring a timely review process such that investments in new technology can be recouped by industry and time to market advantage is not diluted.

One intrinsic benefit of a modern SAS is that it is capable of promoting co-existence between primary and secondary users, and as such can be used in conjunction with inherent sensing capability to gain maximum benefit. Because SAS can be used to facilitate co-existence, specific sensing requirements should not be mandated

It is highly unlikely that receiver saturation or protection from burn out would occur, given the maturity and robustness required by radio access technology to operate reliably in unlicensed bands today.

Because most 3.5 GHz systems would rely on LOS or near LOS operations (notwithstanding low power indoor small cell applications), path loss models will be significantly more reliable and well behaved, than for NLOS operations and performance typically seen on sub 3 GHz bands. For this reason, HAAT and perhaps more aptly antenna height above ground for low power small cells, becomes less significant.

Spectrum Management technology is flexible and can support various band segmentation strategies

Spectrum Bridge's Spectrum Management (SAS) technology is capable of supporting virtually any flexible and dynamic spectrum segmentation or channel plan. Channel plans can be managed in real time, and support an n-tiered ecosystem as a function of time, geography, frequency, radio access technology, or other ecosystem attributes. The technology also supports the ability to apply different rules to different segments of the band. This is substantial in that rules can be modified or optimized over time or adapted on an as needed basis. Simply adopting a rigid band segmentation plan is neither necessary, nor efficient and will result in sub-optimal use of this band. Spectrum Bridge proposes that there be no fixed limit on the division of the band. This would actually enable for situations where priority access may reasonably require more than 50MHz of spectrum and more general access in situations where it does not. Neither should service rules be based on the frequency, with perhaps an exception of the treatment of OOB emissions into adjacent bands. The service rules should be based primarily on geography and co-existence.

Access Coordination and Interference Mitigation Can be enabled by the SAS

Spectrum Bridge has built and relies upon a SAS fully capable of enabling access coordination and interference mitigation techniques. These concepts are often discussed, contemplated and described in industry proceedings and standardization efforts within working groups such as the IEEE and IETF. Although it is far beyond the scope of this response to fully describe the current capability and future potential of such a system, it has already been demonstrated and realized. Some of the capabilities can be appreciated through the following depictions:

These capabilities are reliant upon and realized through the SAS by virtue of a closed loop feedback system, incumbent user data, cloud based processing and coordination between various databases, and sensing technology. Through this coordination, the full potential of a shared spectrum ecosystem is fully realized, even allowing dissimilar radio access technologies to co-exist.

Rules should be adopted that are technology agnostic, to allow and promote the use of existing technology. Sensing and database techniques can be used to promote co-existence and mitigate interference. Requirements that require the use of beacons as a means of enabling interference mitigation is neither practical and will impede innovation.

Requirements should promote innovation and encourage the adoption of technology that already exists. A flexible landscape will allow improvements to be implemented and enabled over time.

Sensing technology should not be mandated by regulatory requirements

It has been repeatedly shown that cost-effectively implementing a sensing technology capable of reliably identifying incumbent operations is marginally feasible, at best. Sensing technology has shown limited utility in TVWS for accurately detecting incumbent operations and can be drastically affected by other influences, e.g. other TVWS devices employing 8-VSB modulation. Furthermore, the challenges and tribulations of equipping UNII band device with reliable radar detection capability also proved very difficult and sometimes unreliable. When these challenges are coupled with potentially evolving radar systems or potentially classified waveforms, this may not be feasible, and result in questionable reliability.

We are not suggesting that sensing technology should be precluded, as it can bring significant value as a complimentary capability in a shared spectrum eco-system. In fact, a geo-location based SAS can be coupled with complimentary sensing technology as it evolves, to enable co-existence, better interference mitigation and perhaps alternative incumbent protection strategies.

The result is that the additional complexity and cost coupled with the incremental sensing reliability is not currently sufficient for ensuring protection for incumbents.

Indoor and outdoor use is needed to realize the full benefit of the 3.5 GHz band

An indoor only limitation is not necessary and would greatly reduce the utility of the 3.5 GHz band for innovative and useful applications such as small cell and small cell backhaul. Indoor and outdoor operations can be accommodated through the SAS, the use of geo-location technology and radio use policies implemented within radio device(s). Devices in many outdoor environments can utilize GPS (or other) technology to derive location with varying degrees of accuracy. Devices can then report their location to the SAS, which can determine and provide channel availability based on location measurement confidence, accuracy and other factors to ensure the appropriate protection is applied to protect incumbent or other priority users. It is important to note that GPS technology is no longer the only method available to accurately determine location.

It is also essential that provisions be made to allow devices to operate indoors, or without access to GPS (or other) location technology. An example of how indoor use is facilitated has been implemented in the TVWS rules and ecosystem. Again, it should not be assumed that devices operating indoors cannot derive a reasonably accurate location, and in conjunction with the SAS, ensure that appropriate operating parameters are provided to devices to ensure protection to incumbents.

One effective means to determine if a device is indoors is the lack of access to a GPS or other signal(s). Although this is not always the case, it is generally congruent with the concept and desire to operate in this condition with a lower transmit power. If outdoor-like operational modes require access to a stronger reference signal (e.g. GPS) to operate at high power, this situation is generally 'fail-safe'.

As the FCC notes, it is not possible to guarantee that a device sold as authorized for indoor use, will not be used outdoors. Many examples can be found in consumer Wi-Fi Access Points that have been mounted outdoors, often in nothing more sophisticated than a plastic food container. Many public park pavilions shelter Wi-Fi access points so assuming indoor building attenuation is not reasonable or practical.

It is essential that both indoor and outdoor operation is permitted, albeit using different operational parameters, to ensure economies of scale are realized within the industry and that the full benefit of this spectrum is realized.